

## **A Review of Experimental study of brake lining materials**

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**Abstract-** A brake lining composition was investigated experimentally to investigate the effects of the manufacturing parameters on the tribological properties and to obtain optimal manufacturing parameters for improved tribological behaviour. Brake linings are important parts in braking systems for all types of vehicles. They convert the kinetic energy of the car to thermal energy by friction in the contact zone . The complicated series of events that occur in the contact zone play a crucial role in the tribological behaviour of the brake lining materials and have been investigated by many researchers over many years . The frictional forces and wear behaviour of the brake lining change continuously during braking, depending on various factors, such as driving conditions, brake lining formulation, manufacturing parameters and the characteristics of the friction film that accumulates at the interface between the rotor and friction material .

**Key Word-** brake lining , brake material ,experimental approach

### **1 -Introduction-**

A brake is a mechanical device which inhibits motion. The rest of this article is dedicated to various types of vehicular brakes. Most commonly brakes use friction to convert kinetic energy into heat, though other methods of energy conversion may be employed. For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other

braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

Brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing.

## 2-Types of brake

Brakes may be broadly described as using friction, pumping, or electromagnetics. One brake may use several principles: for example, a pump may pass fluid through an orifice to create friction:

- **Frictional brakes** are most common and can be divided broadly into "shoe" or "pad" brakes, using an explicit wear surface, and hydrodynamic brakes, such as parachutes, which use friction in a working fluid and do not explicitly wear. Typically the term "friction brake" is used to mean pad/shoe brakes and excludes hydrodynamic brakes, even though hydrodynamic brakes use friction. Friction (pad/shoe) brakes are often rotating devices with a stationary pad and a rotating wear surface. Common configurations include shoes that contract to rub on the outside of a rotating drum, such as a band brake; a rotating drum with shoes that expand to rub the inside of a drum, commonly called a "drum brake", although other drum configurations are possible; and pads that pinch a rotating disc, commonly called a "disc brake". Other brake configurations are used, but less often. For example, PCC trolley brakes include a flat shoe which is clamped to the rail with an electromagnet; the Murphy brake pinches a rotating drum, and the Ausco Lambert disc brake uses a hollow disc (two parallel discs with a structural bridge) with shoes that sit between the disc surfaces and expand laterally.
- **Pumping brakes** are often used where a pump is already part of the machinery. For example, an internal-combustion piston motor can have the fuel supply stopped, and then internal pumping losses of the engine create some braking. Some engines use a valve

override called a Jake brake to greatly increase pumping losses. Pumping brakes can dump energy as heat, or can be regenerative brakes that recharge a pressure reservoir called a hydraulic accumulator.

- **Electromagnetic brakes** are likewise often used where an electric motor is already part of the machinery. For example, many hybrid gasoline/electric vehicles use the electric motor as a generator to charge electric batteries and also as a regenerative brake. Some diesel/electric railroad locomotives use the electric motors to generate electricity which is then sent to a resistor bank and dumped as heat. Some vehicles, such as some transit buses, do not already have an electric motor but use a secondary "retarder" brake that is effectively a generator with an internal short-circuit. Related types of such a brake are eddy current brakes, and electro-mechanical brakes (which actually are magnetically driven friction brakes, but nowadays are often just called "electromagnetic brakes" as well).

### 3-Characteristics

Brakes are often described according to several characteristics including:

- **Peak force** – The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid.
- **Continuous power dissipation** – Brakes typically get hot in use, and fail when the temperature gets too high. The greatest amount of power (energy per unit time) that can be dissipated through the brake without failure is the continuous power dissipation. Continuous power dissipation often depends on e.g., the temperature and speed of ambient cooling air.
- **Fade** – As a brake heats, it may become less effective, called brake fade. Some designs are inherently prone to fade, while other designs are relatively immune. Further, use considerations, such as cooling, often have a big effect on fade.
- **Smoothness** – A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids. For example, railroad wheels have little traction, and

friction brakes without an anti-skid mechanism often lead to skids, which increases maintenance costs and leads to a "thump thump" feeling for riders inside.

- **Power** – Brakes are often described as "powerful" when a small human application force leads to a braking force that is higher than typical for other brakes in the same class. This notion of "powerful" does not relate to continuous power dissipation, and may be confusing in that a brake may be "powerful" and brake strongly with a gentle brake application, yet have lower (worse) peak force than a less "powerful" brake.
- **Pedal feel** – Brake pedal feel encompasses subjective perception of brake power output as a function of pedal travel. Pedal travel is influenced by the fluid displacement of the brake and other factors.
- **Drag** – Brakes have varied amount of drag in the off-brake condition depending on design of the system to accommodate total system compliance and deformation that exists under braking with ability to retract friction material from the rubbing surface in the off-brake condition.
- **Durability** – Friction brakes have wear surfaces that must be renewed periodically. Wear surfaces include the brake shoes or pads, and also the brake disc or drum. There may be tradeoffs, for example a wear surface that generates high peak force may also wear quickly.
- **Weight** – Brakes are often "added weight" in that they serve no other function. Further, brakes are often mounted on wheels, and unsprung weight can significantly hurt traction in some circumstances. "Weight" may mean the brake itself, or may include additional support structure.
- **Noise** – Brakes usually create some minor noise when applied, but often create squeal or grinding noises that are quite loud.

#### 4-Brake Linings



Brake linings are a friction material which help control movement of a vehicle. Brakes use friction to transmit force to a moving part of a vehicle (usually the wheels) to slow or stop it completely. Among the components of a braking system are brake pads, or brake shoes, which consist of a brake lining bonded to a metal backing. When the brake is engaged, the pad or shoe is pressed against a metal disc or drum attached to the wheel, causing it to slow or stop. The forward motion of the wheel is converted into heat, subjecting the brake linings to high temperatures. Because of this, brake linings have customarily been made with asbestos.

Most vehicles employ multiple sets of brake pads and one or more clutches. Brake pads and shoes are typically sold in pairs.

## **Working with Brake Lining**

Automotive mechanics remove and replace worn linings or even resurface linings on a daily basis. Many car owners, especially of older or vintage cars, may do this work themselves, and may have a friend or family member assist them.

Assembly-line workers may install brakes in new vehicles. Auto parts manufacturers may assemble new brakes, or reline old pads and shoes. Operators of heavy machinery who do their own maintenance may also replace old linings. Junkyard operators may also handle friction materials.

**5- Literature-** By research paper, Brake linings are produced using powder metallurgy (P/M) according to two steps; first, hot molding of a mixture under high pressure and second, subsequent heat treatment (post-curing). One of the most critical and controlled steps in the P/M process is molding because product density and uniformity are determined by this step. The molding involves several stages: initial molding, elastic–plastic deformation and particle fracture or fragmentation. The initial stage is mostly affected by the particle size and shape.

During the initial stage, densification progresses via the rearrangement of powder particles, leading to the filling of large voids and the break up of particle bridges. In the elastic–plastic stage, the elastic deformation of the particles becomes a contributor to the process of densification. As the applied pressure is further increased, plastic deformation occurs locally at the interparticle contact points and here the mechanical properties and the quality of the particles are important factors, because they control the compressibility behaviour of the powder. In the final stage of molding, plastic deformation becomes widespread, accompanied by shearing, generation of new oxide-free surfaces, and cold welding of contacting surfaces, accompanied by reduction in porosity.

Heat treatment, as one of the most basic and important processes in brake lining manufacturing, causes particles of amaterial to join together, gradually reducing the volume of pore space between them, enhances curing uniformity, reduces thermal expansion during service

and may play a crucial role in the properties and cost of final products. The most important factors involved during the heat treatment process are temperature, time and furnace atmosphere.

Generally, the molding and heat treatment parameters of the brake friction materials are defined by the resin manufacturer. This is because manufacturing conditions of brake linings are affected mostly by the thermal properties of the binder resin, such as flow distance and gel or 'B' times. Phenolic resins (modified and unmodified) are invariably used as binders in friction materials due to their low cost and good combination of mechanical properties, such as high hardness, compressive strength, moderate thermal resistance, creep resistance and very good wetting capability with most ingredients .

Although there are as many as 15 components, including phenolic resin binder, in the brake lining formulation, the binder resin strongly affects important aspects of brake performance, such as fade resistance, pedal feeling, wear resistance and noise propensity, among others. Especially, fade behavior resulting from the high temperatures observed during braking are directly related to the molecular structure of the resin . The fade phenomenon in friction materials was explained by the thermal decomposition of ingredients in friction materials at elevated temperatures, and as a consequence, the friction force drops or decreases substantially to an unacceptably low level, which reduces braking efficiency and reliability .

Therefore, to improve frictional stability at high temperatures, the resin should be modified to obtain minimal dependence on the temperature , and the manufacturing parameters should be selected within optimum limits. In our study, the experimental results are analysed within a functional framework. This framework is based on comparison and selection of the molding and heat treatment parameters of the brake lining to obtain the best performance in terms of the tribological characteristics and manufacturing cost.

**6-Conclusion-** As the molding pressure increased, the average COF of the brake lining increased, given constant heat treatment parameters, molding temperature and time. However, the stability of COF related to the test temperature, the number of braking and wear resistance decreased at high molding pressure. The same behaviour was also seen at low molding pressure.

The results obtained from tests showed that the heat treatment time did not have a significant effect on the tribological properties of brake lining material compared to other parameters. Only the wear resistance of the material was slightly decreased at high heat treatment times.

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